Rappahannock Non-Tidal River
2008

Introduction

The Rappahannock River is one of Virginia's top destinations for smallmouth bass angling, canoeing and camping along an almost completely unspoiled historical river corridor. The character of this river changes abruptly in Fredericksburg at the fall line (the limit of tidal influence) literally beneath U.S. Route 1. Above this point, the river is typically clear, swift, and dominant substrates are bedrock, boulder and cobble – perfect habitat for smallmouth bass, rock bass, redbreast sunfish and related species. Virginia designates the entire nontidal portion of the Rappahannock River at a 'State Scenic River'. Below U.S. Route 1, the river is tidal, the substrate is finer – dominated by sand, and the water is frequently murky. Species composition shifts with habitat, and largemouth bass, catfish and anadromous species are common in and below Fredericksburg.

Embrey Dam, once a blockage to migratory fish and canoeists alike, was breached on February 23rd 2004 reopening 71 miles of the main stem Rappahannock River and 35 miles of the Rapidan River, a major tributary, for a total of 106 miles of historically known spawning and rearing habitat for migratory shad and herring. Another landmark event for the Rappahannock River occurred in 2007 when a permanent conservation easement was recorded putting over 4200 forested acres into a trust managed by the Nature Conservancy, the Virginia Outdoors Foundation and the Virginia Department of Game and Inland Fisheries. Over 32 miles of main stem river are included in these lands, previously owned by the City of Fredericksburg, allowing for an unprecedented level of primitive floating, fishing, camping and other outdoor recreational pursuits.

Investigations of the fisheries resources of the Rappahannock system are usually stratified between tidal and non-tidal because of the noted differences in habitat, associated fish communities and survey gear selection. This report concerns the non-tidal (hereafter referred to as "upper" waters) with emphasis on smallmouth bass. A companion report under different cover concerns the tidal (or "lower" waters) with emphasis on largemouth bass.

Access

Access to the upper Rappahannock system (defined here as the Rapidan and Rappahannock Rivers) is limited and fairly primitive. Established access points on the Rappahannock (traveling downstream) are at Kelly's Ford (Route 672 off Route 651) in

Culpeper County and Motts Landing (Route 618) in Spotsylvania County. About 25 miles separates these canoe/jon boat slides, and an overnight camp stop is nearly mandatory for those that float fish this reach. Another access point is located on the Rapidan River at Elys Ford (Route 610) in Spotsylvania County about 14 miles upstream of Motts Landing. This access has a concrete slab boat ramp, but attempting to launch trailered boats is not recommended. It is, however, an excellent canoe access point. A primitive and steep access point is available along the Department's Raccoon Ford property downstream of Route 522 along Route 611 (right-hand bank). Access may also be gained via several "non established" points – these consisting of VDOT rights-of-ways along bridges (e.g., Routes 3 and 522 on the Rapidan and Route 29 on the Rappahannock). Parking may be a problem in the latter cases, and many anglers choose one of the canoe liveries that have agreements with landowners and provide floats of varying length from access points not available to the general public. For more information, contact Clore Brothers (540-786-7749), Rappahannock Outdoor Education Center (540-371-5085) or Rappahannock River Campground (800-784-7235). There are no ramps on the upper Rappahannock River recommended for trailers, and boat use should be restricted to canoes and kayaks.

Methods

On the upper Rappahannock system, annual multi-station electrofishing began in 1996 and has continued through 2006. Unfortunately, standardized samples could not be conducted in 2007 due to extreme low flows. Generally, four sites are sampled by small boat electrofishing for all fish species each October. Sampling sites are located adjacent to Laucks Island (within Fredericksburg), above I-95 (just upstream of Fredericksburg), Elys Ford (middle Rapidan River in Spotsylvania County) below Kelly's Ford (upper Rappahannock in Fauquier County). Three 1200-second electrofishing runs are made at each site annually, and all species are collected, measured for total length and released back into the river. Periodically, samples of game species are transported to a laboratory for more detailed examination including weight, otolith (ear bone) extraction (for precise age estimation), and diet analysis. Data from otoliths is necessary to determine spawning success (recruitment index), growth and mortality rates. Additionally, more intensive depletion electrofishing was conducted at these four sites during 2001 – a technique involving the sequential removal of individuals from within a known area with multiple vessels. This survey allowed Rappahannock River fish population estimates and biomass calculations for the first time and is discussed in greater detail below. This sampling will be replicated in 2009 to assess the changes to the fish community since the removal of Embrey Dam. Unfortunately, drought conditions during fall 2007 forced the cancellation of standard small boat electrofishing. However, because 14,725 smallmouth bass fingerlings were supplementally stocked in July 2007, stocking sites were surveyed with tote barge electrofishing gear. Tote barge gear is used in smaller, shallower streams and rivers by biologists wearing chest waders. Only smallmouth bass were collected, and all potential juvenile (stocked or wild) were retained for otolith extraction. Otoliths, or ear bones, are not only used to determine the age of a fish, but these structures can also be marked, or stained, when fish are young by immersion in a bath containing certain

chemicals such as oxytetracycline (OTC). OTC marks enable biologists to determine the contribution of stocked fish to a population that also has natural reproduction.

The first upper Rappahannock River creel survey was conducted in 1998. The creel survey was duplicated in 1999 because of a drought that began in late spring, 1998. Unfortunately, the drought worsened in 1999. Creel surveys are valuable because they provide fisheries managers with the "human component" of the fisheries equation – e.g., estimates of angler preferences, success and harvest (versus sampling by electrofishing which is the best way to obtain biological data about fish populations). Based on creel surveys, it is conservatively estimated that the Rappahannock system annually supports about 24,000 angler visits totaling nearly 100,000 hours of fishing pressure. The majority of anglers surveyed (67%) targeted smallmouth bass, but only 1% of bass caught were harvested. This survey will be replicated in 2009 to better assess angler characteristics and desires.

Results

Fisheries studies included all species but focused primarily on smallmouth bass due to its importance as a game fish. As with other species, three primary factors govern the density and size structure of the smallmouth bass population: recruitment, growth and mortality.

One of the most important factors governing smallmouth bass population size is recruitment or year class strength (the number of individuals spawned in a given year that survive to become part of the population). Year class strength is a function of many variables including both biotic and abiotic (e.g., environmentally related) and can fluctuate dramatically from year to year (Table 1). Data have shown that a large amount of variability associated with year class strength can be attributed to spring river flows - primarily average rive flow during June. This post-spawn month seems to be critical in determining the outcome of a year's spawn, as too much or not enough water impede recruitment. Flows of around 500-1200 CFS (average June flow in cubic feet per second from the Fredericksburg gauge) seem to provide good spawns, but recruitment drops rapidly after about 1800 CFS suggesting high flows are more damaging than low flows. Record production occurred in 2004 when mean catch per unit effort (CPUE – number of fish collected per hour of active electrofishing time) of juvenile smallmouth bass was 43 per hour. Prior to this extraordinary year class, 1997 held the distinction of producing the best smallmouth bass year class in many of Virginia's rivers. Incredibly enough, the 2004 year class was followed in 2005 with one equal in strength to 1997. During the 5-year period from 2002-2006, only two year classes were below average, and 2007 appeared to be a good year based on supplemental barge sampling. Thus, anglers should benefit from the excellent recent production of strong year classes for several years.

History has shown that strong smallmouth bass year classes are persistent and likely fuel numbers of citation fish. When smallmouth bass experience good spawning, the average size of young fish is often significantly higher than in years when fewer individuals are produced. This suggests that competition between bass is not occurring

(at least during the first year) and that the same variables that favor high reproduction also favor growth of young fish. This was partial impetus behind the experimental stocking program on several Virginia rivers – to determine if through supplemental stocking, a good year class could be made a great one; or if a failed year class could be made average. The intent was not to stock every year or even when a poor year class occurred (highly variable year classes are natural and may be beneficial in many populations) but to address repeated reproductive failures. However, the experimental smallmouth bass stocking on the Rappahannock at five sites in 2007 did not appear to contribute to the population. Only 1 fish out of 105 was of hatchery origin. It is unknown why survival of stocked fish was so low, but many literature accounts of black bass supplemental stocking (placing hatchery fish in otherwise healthy natural populations) have been unsuccessful.

The second feature of smallmouth bass population dynamics – growth – is relatively slow in the Rappahannock River (Table 2). For example, the following sizes corresponded to fish aged 0-3 (fish were collected in fall, so an additional growing season had elapsed – e.g., an "age 1" fish was actually about 1.5 years old): 4.1", 6.9", 8.5" and 9.9". Age 5 smallmouth bass (six growing seasons) averaged only 13.1". Forage may be a limiting factor, as many of the smallmouth bass stomachs examined during survey periods were empty or contained only detritus. Most of prey items that could be identified were redbreast sunfish. Other items commonly encountered (in decreasing abundance) included crayfish, aquatic insects (e.g., stoneflies and hellgrammites), terrestrial insects and darters. Changes to the upper river fish community as a result of Embrey Dam's demise should provide Rappahannock smallmouth bass with a larger and more diverse forage base. Growth rates will be reevaluated in 2009.

In addition to slow growth, smallmouth bass seem to be experiencing high mortality. The portion of the population that is removed each year (total annual mortality) is made up of fishing and natural mortality. Total annual mortality of Rappahannock smallmouth has been estimated between about 40% and 80% depending on year class (a group of fish spawned the same year) and age. Some of the most statistically significant total annual mortality estimates were for the 1997 and 1998 year classes (58% and 51% for ages 1-4). This represents a fairly high mortality rate, and it is believed (based on creel surveys) that most of the mortality is natural, as harvest averaged just 1% of smallmouth bass caught during creel years. However: harvest of large fish may be disproportionate, as 19% of registered citations were kept between 2004 and 2007 (Table 3). The trend of releasing citation smallmouth bass has increased significantly in recent years even as the submission rate has been cyclic (currently rising). Fishing *related* mortality (e.g., delayed hooking mortality) may also be a factor.

Electrofishing surveys indicated that abundance of smallmouth bass was cyclic and averaged about 50 fish per hour (Table 4). Year class strength (variable recruitment) was responsible for a great deal of the variability in CPUE (since much of the population was composed of only two or three year classes at any given time), but some of the variability may have been a function of sampling conditions. Recent catch rates (2004-2006) have all been average or above average. Perhaps even more encouraging than the

recent high catch rates was the improvement in size structure. The size distribution of the smallmouth bass population (as defined by the index Relative Stock Density of Preferred fish, or RSD-P - a ratio of adult fish that were 14" or greater) reached a record high (13) in 2006. Simply stated, the higher the RSD value, the higher the percentage of large fish in the population (14" is the nationally accepted standard for "preferred" size smallmouth bass). Contributions from the strong year classes of 2004 and 2005 should allow this index to remain high and perhaps even increase over the next few years.

Harvest restrictions were recently placed on several Virginia smallmouth bass populations in other rivers (large slot length limits with reduced creels or "trophy" regulations). A similar regulation was evaluated for the Rappahannock River but discounted due to 1) slow growth of Rappahannock River smallmouth bass, 2) marginal population model yield, 3) high voluntary release rate, 4) high angler satisfaction with current regulations, 5) absence of a small, ineffective slot limit, and 6) limited access with which to establish a section that could be evaluated.

Smallmouth bass grow more slowly in the Rappahannock River than in other large Virginia Rivers (e.g., age 4 fish averaged almost 13" in the James River and well over 12" in the New River but only 11.6" in the Rappahannock River). Thus, it takes substantially more time for fish to reach a given size in the Rappahannock River, during which time more bass succumb to high annual mortality. It is believed that most of this mortality is related to natural causes and not fishing, and this slow growth combined with high natural mortality would undermine a harvest restriction aimed at protecting large fish.

Potential changes to the Rappahannock River smallmouth bass population were modeled with FAST (Fishery Analysis and Simulation Tool) – a computer program designed to simulate changes to a fishery based on biological parameters under variable harvest restrictions. Output indicated that 59 trophy (>20") smallmouth bass were present in the system under the current regulation (no minimum size). However, a projected change to a 14-20" slot length limit only increased that number to 67 – a marginal 14% increase. It is difficult to justify this change, given the other issues, for an increase of eight fish.

Creel surveys conducted in 1998 and 1999 documented an extraordinarily high voluntary release rate of smallmouth bass (99%). A release rate of this magnitude would negate an attempt to restructure the population with a length limit of any type – the limited harvest would simply not have a population level impact.

Anglers indicated that they were satisfied with the current regulation in the 1998 and 1999 creel surveys. During both surveys, 84% of anglers stated that they were happy with the current regulation – this consistency was noteworthy. Only 12% favored more restrictive regulation in 1998, while 15% in chose this option in 1999. Changing a regulation against the overwhelming majority of users' wishes seems a dubious proposition, especially given the options that are now available to them on other Virginia rivers.

A five fish per day bag limit with no minimum size currently governs smallmouth bass harvest on the Rappahannock River. However, other rivers had small, ineffective slot length limits (e.g., 11-14") prior to the change to a large slot length limit. The failure of these small slot length limits to meet objectives necessitated a need for corrective action. Additionally, higher harvest of large fish was either documented or perceived and should enable the new large slot length limits to more effectively restructure the populations.

Due to limited access on the Rappahannock River, an experimental section with which to test a new regulation would be difficult to enforce. Currently, only three access points are present on the entire system (Elys Ford on the Rapidan, and Kelly's Ford and Motts Landing on the Rappahannock). Because anglers typically float from one of the upper landings to Motts, they would potentially travel through water that would be both subject to a new regulation and governed by the old regulation. The alternative would be to change the regulation on the entire river system thereby eliminating any control section to evaluate such a change. In short, the Rappahannock does not lend itself, at this time, to the easy evaluation and enforcement of a regulation change. Following creel and depletion surveys in 2009 and reevaluation of age and growth patterns, another simulation will be attempted to determine if more restrictive harvest regulations should be considered.

Electrofishing gear sampled other popular species in the Rappahannock system including redbreast sunfish and rock bass. In all years surveyed, redbreast sunfish were more abundant than rock bass, and the two species combined composed 35% of the fish community (by number) in 2006. Species once collected only below Embrey Dam such as gizzard shad, channel catfish, white perch, yellow perch, and striped bass were observed as far upstream as Ely's Ford and Kelly's Ford. The abundance of channel catfish increased rapidly, and it is likely this population will soon rival that of the Shenandoah River. No blue catfish were collected above the old dam site despite a dramatic colonization over the past 25 years in tidal waters.

Data collected during the week of depletion sampling in 2001 provided a plethora of opportunities including 1) the estimation of smallmouth bass population size and biomass, 2) further "ground truth" comparisons of fall single-pass electrofishing data, 3) the categorization of species contribution to the overall fish community, and 4) a better (though not comprehensive) species list of the system.

Smallmouth bass population estimates for the Rappahannock River derived from depletion sampling were 621 adult (age 1 and over) and 356 young-of-year per mile. A conservative estimate for total smallmouth bass in the system was about 115,000 fish. Obviously, this figure was subject to a great deal of bias having been computed from only four sample sites; however, it represented a starting point. Similarly, total smallmouth bass biomass (or standing crop) was estimated at about 9 pounds per acre – a value consistent with estimates derived from the James River by DGIF in 2002 and Virginia Commonwealth University in earlier studies.

Depletion sampling also allowed the categorization of species composition. The top five species collected by number (with number captured in parentheses) were redbreast sunfish (968), smallmouth bass (484), rock bass (480), northern hogsucker (122) and bluegill (114). Four of these species belonged to the sunfish family indicating the Rappahannock system is "sunfish heavy" – a contrast to other river systems such as the James were herring and catfish species comprised a large portion of the community (Table 5). The top five species collected by weight (with percent contribution to total weight in parentheses) were smallmouth bass (20%), redbreast sunfish (17%), northern hogsucker (12%), white sucker (10%) and rock bass (9%). Additional species collected and their contribution to total weight are listed below (Table 5). These 35 species are by no means an exhaustive list, but are illustrative of the upper Rappahannock River fish community prior to the breaching of Embrey Dam. The community is likely to appear much different when evaluated in 2009.

Table 1. Mean catch per unit effort (CPUE – fish/hr) of juvenile (age-0) smallmouth bass at four sites on the Rappahannock River system.

1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
0	0	28	14	11	12	14	18	3	43	28	12

Table 2. Smallmouth bass growth rate (length-at-age) for fish collected fall, 1996-2002 on the Rappahannock River system (Mean=mean total length in inches).

Age	0	1	2	3	4	5	6	7	8
Mean	4.1	6.9	8.5	9.9	11.6	13.1	15.4	15.8	17.9

Table 3. Smallmouth bass citations awarded to anglers for trophy fish catches (>20") between 1996 and 2007 in the Rappahannock and Rapidan Rivers (combined) with percentage released. Length citations began in 1996.

1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
18	18	19	25	24	35	27	14	6	14	17	22
61%	39%	58%	52%	38%	57%	70%	50%	83%	79%	76%	86%

Table 4. Smallmouth bass abundance (CPUE, or catch per unit effort) based on number collected per hour of electrofishing at four sites on the Rappahannock River system with percentage of adult population > 14" (RSD-P, relative stock density - preferred).

1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
20	27	46	59	67	63	65	48	38	62	51	49
4%	4%	5%	4%	4%	5%	1%	3%	10%	3%	6%	13%

Table 5. Fish species collected at four sites during depletion electrofishing in July 2001 with percent contribution to total weight in parentheses (t=trace).

Sunfish family Centrarchidae (48%)
Rock bass *Ambloplites rupestris* (9%)
Black crappie *Pomoxis nigromaculatus* (t)
Smallmouth bass *Micropterus dolomieu* (20%)
Largemouth bass *Micropterus salmoides* (t)
Green sunfish *Lepomis cyanellus* (t)
Redbreast sunfish *Lepomis auritus* (17%)
Bluegill *Lepomis macrochirus* (2%)
Pumpkinseed *Lepomis gibbosus* (t)
Redear sunfish *Lepomis microlophus* (t)

Perch family Percidae (t)
Yellow perch *Perca flavescens* (t)
Tessellated darter *Etheostoma olmstedi* (t)
Glassy darter *Etheostoma vitreum* (t)
Greenside darter *Etheostoma blennioides* (t)

Lamprey family Petromyzontidae (t)
American brook lamprey *Lampetra appendix* (t)

Eel family Anguillidae (8%)
American eel *Anguilla rostrata* (8%)

Herring family Clupeidae (2%)
Gizzard shad *Dorosoma cepedianum* (2%)

Minnow family Cyprinidae (2%)
Common carp *Cyprinus carpio* (t)
Golden shiner *Notemigonus crysoleucas* (t)
Fallfish *Semotilus corporalis* (1%)
River chub *Nocomis micropogon* (1%)
Satinfin shiner *Cyprinella analostana* (t)
Common shiner *Luxilus cornutus* (t)
Comely shiner *Notropis amoenus* (t)
Spottail shiner *Notropis hudsonius* (t)
Swallowtail shiner *Notropis procne* (t)

Sucker family Catostomidae (27%)
Northern hogsucker *Hypentelium nigricans* (12%)
Shorthead redhorse *Moxostoma macrolepidotum* (5%)
White sucker *Catostomus commersoni* (10%)

Catfish family Ictaluridae (10%)
Channel catfish *Ictalurus punctatus* (7%)
White catfish *Ameiurus catus* (t)
Yellow bullhead *Ameiurus natalis* (3%)

Brown bullhead *Ameiurus nebulosus* (t)
Margined madtom *Noturus insignis* (t)

Bass Family Moronidae (1%)
White perch *Morone americana* (t)
Striped bass Morone saxatilis (t)

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